Chapter 3: RESULTS

What We Learned and Achieved In 2001

All of the efforts described in Chapter 2 were aimed at protecting King County's groundwater resources. This is a long-term effort, and results of such effort may only be measurable over time. There are, however, some achievements and results from activities in 2001 that are noteworthy, which will be discussed in this section.

Data Collection and Management

Routine monitoring of groundwater should show the quality of the groundwater resource at any given time, the identity of problems or threats, and any long-term trends that need to be addressed. A comprehensive monitoring program for King County's groundwater, though desirable, has yet to be developed. However, during 2001, the Program conducted ambient monitoring rounds that were the first in nearly a decade. DNRP staff were reviewing the data from these samples as this report was being prepared, so some of the results reported here should be considered provisional.

Ambient water quality monitoring

The results from the groundwater monitoring efforts described in Chapter 2 have been analyzed using a variety of methods. The following parts of this section of the report describe the different kinds of interpretation of the data:

- General appreciation of the data.
- Overall changes in groundwater quality and quantity, as estimated for the Environmental Benchmarks report.
- How the results compare to water quality standards.
- Locations where water quality appears to be changing from the previous sampling in 1989–95.

Summary of results

The results from a sampling in 2001 indicate that groundwater in King County is high quality and has remained that way over the past decade. Isolated locations contain unacceptable concentrations of a few chemicals such as arsenic (a problem nationwide and even worldwide), nitrates, and synthetic organic chemicals. The data suggests that concentrations of different contaminants around the County have increased or decreased since the sampling in the late 1980s to early 1990s. These apparently conflicting trends will require careful analysis to identify the changes and possible explanations.

The chemical data from the sampling rounds is included in a summary table in Appendix B.

What Was Found in King County Groundwater?

EPA and the Washington State Board of Health have established health-based standards for the most common contaminants that appear in drinking water sources. These generally are known as "maximum contaminant levels," or "MCLs," which mean that they are the highest level of that contaminant that may be safely consumed in drinking water over a long period of time without creating a significant human health risk. Some contaminants have a "secondary" MCL, which means that, although water with the contaminant at that level does not create a health risk, it may create aesthetic problems (e.g., taste or odor) that a water system might want to address by treating the water to reduce or eliminate the contaminant. The analytical data from DNRP's 2001 ambient groundwater sampling was compared to these MCLs. The comparison is summarized in Table 3-1.

Table 3-1. Comparison with Drinking Water Standards

Chemical Parameter	Maximum Contaminant Level (MCL)	Wells exceeding MCL
Arsenic	50 µg/l	2*
	new MCL, 10 µg/l	11 over new MCL
Nitrate	10 µg/l	2
	5 µg/l "trigger level"	4 over trigger level
Iron	300 µg/l (Secondary MCL)	22
Manganese	50 µg/l (Secondary MCL)	25
Sodium	20 mg/l ("recommended level")	6

* = One of these samples with an exceedance of arsenic MCL had high turbidity and was resampled immediately and found to be below MCL. The high level is thought to be partly a result of the sampling process.

The Iron and Manganese drinking water standards (MCLs) are considered "secondary" MCLs, with no associated health risk. The "recommended level" for sodium is a concern for people who are on a low sodium diet.

In addition to these samples that showed chemical contaminants above acceptable health standards, a few samples had detections of "total coliform" and other types of bacteria. Drinking water with bacteria and viruses also violate health standards. Generally, detections of bacteria are considered problems of contamination occurring at the well location, as opposed to bacteria being in the groundwater. For each sample where bacteria were detected, Program staff contacted the well owner to advise them of the apparent contamination and methods of disinfecting their well head, and referred them to Public Health. Staff resampled the water at a tap to assure that the water supply was adequately treated.

These data show that groundwater in King County is generally of high quality and meets drinking water standards.

DNRP staff arranged for the samples taken in 2001 to be analyzed for a wide range of organic contaminants, using a variety of laboratory methods. Such organic compounds are man-made, often industrial chemical, and indicate serious contamination problems like those found at hazardous waste sites. As of the date this report was being prepared, the results from these analyses were still somewhat uncertain, and some may require confirmation resampling to be sure of the results.

The wells that were sampled generally are located away from industrial areas that might create contamination from hazardous waste spills. However, the analyses showed the existence of some chemicals at a few locations:

- Trichloroethylene (TCE) was detected at a well in the Issaquah Creek Valley Groundwater Management Area. The well is located on Cedar Grove Road, near the divide between Issaquah Creek and the Cedar River. The TCE concentration was 0.12 µg/l, well below the MCL of 5 µg/l. TCE is known to be in this area, emanating from the Queen City Farms Superfund site just to the north, based on EPA sampling over several years.
- Tetrachloroethylene (PCE) and chloroform were detected in a water supply well belonging to the City of Redmond. The concentrations were (respectively) about 0.2 and 0.1 µg/l, well below the MCLs of 5 and 80 µg/l. The contaminants have been detected in the past and reported to the Washington State Department of Health. They apparently derive from a spill at a dry cleaner across the street from the well.
- Atrazine was detected at a well at a maintenance yard for the King County Dept of Transportation at a concentration of about 0.05 µg/l, which is well below the MCL of 3 µg/l. Atrazine (commercial name Aatrex) is an herbicide that has commonly been used in road rights of way. Discussions with long-time employees indicate the chemical was stored more than ten years ago at this location.

All the detections are consistent with known or potential contamination.

A number of detections were made involving a family of chemicals called *phthalates*, which are used in plastic materials, including plumbing PVC. Of all these phthalates, only the one associated with PVC has a drinking water MCL–of 6 µg/l–which was exceeded at three locations in King County. Because these results were unexpected, and might have been due to sampling problems, DNRP staff is conducting follow-up resampling and reanalysis to confirm the highest levels of phthalates or reject their presence.

Three other organic contaminants were detected: benzoic acid (six wells), phenol (ten wells), and phenanthrene (one well). None of these have health-based MCLs, but will continue to be monitored by DNRP staff.

The laboratory analyses also produced approximately 108 “tentatively identified compounds (TICs).” This means that there may be some other substances in the water, although the analytical methods were not targeting these substances specifically.

Generally, the identities and concentrations of these substances are not considered accurate. The only TICs with MCLs had simultaneously been analyzed with regular laboratory methods. DNRP staff will review the results will be reviewed for significance, and may decide to sample again and test with laboratory methods that target the compounds specifically.

This organic analysis showed no detection of the chemicals associated with gasoline and other petroleum products, which are commonly found at hazardous waste sites because of the widespread use and spillage of petroleum products. The chemicals probably would show up again if groundwater sampling were extended to the more industrial areas of King County, such as the Duwamish flats, or locations where use of petroleum products (e.g., closed gasoline stations) are likely to have produced some contamination from leaking tanks or other facilities.

The data from the 2001 round of samples may be useful as part of salmon recovery and habitat protection efforts. Concentrations of the detected chemicals may be evaluated based on known impacts to fish, especially species listed as threatened under the Endangered Species Act, even where there is no apparent human health risk. This type of an analysis will be complicated because the prioritized "Factors of Decline" for the fish have not been finalized, research on fish impacts from such chemicals is incomplete, and many substances in groundwater change when they emerge into the surface water environment.

Has Groundwater Quality Changed?

The analytical data from the first round of ambient sampling was used to measure how well King County is protecting its water quality and quantity. The results were published in *The 2001 King County Benchmark Report,* September 2001. This report can be reviewed at http://www.metrokc.gov/exec/orpp/benchmrk/bench01/.

Groundwater is considered under the objective, "Protecting Water Quantity and Quality" as Indicator 15: "Changes in groundwater levels and groundwater quality." The analysis done for the Benchmark Report was incomplete because it did not contain all of the monitoring data obtained through the end of 2001.

Following completion of the 2001 round of sampling, DNRP staff compared the water quality data from the current sampling with similar data from the decade-old results in the same wells. The differences between the concentrations were observed at different times. The results were interpreted as long term trends in general groundwater quality. In the preliminary data, some chemicals (potassium, iron, and magnesium) appeared to increase in concentration. With more rigorous analysis, the only changes in average water quality found to be statistically significant were those where 2001 data showed a lowered concentration (i.e., improving water quality) for copper, fluoride, lead, zinc, chromium, nitrate.

A "Change in Concentration" is defined statistically as a change in average concentration, across all the wells sampled, that would occur randomly in only 5% of

analyses ("95% confidence"). It appears from this analysis that health concerns from drinking King County's groundwater have been reduced over the decade.

The statistics indicate that changes in contaminant concentrations are very subtle. The cited effects could be due to other factors such as the season when samples are taken, climatic differences, changes in laboratory methods or detection limits or localized changes over one of the Ground Water Management Areas or even at an individual well (see next section). DNRP staff are presently performing separate statistical and other analyses, to interpret and account for these effects. To gain a higher level of confidence in the results would require a larger number of samples, from a broader geographic area, taken more frequently.

The water level (quantity) data were similarly analyzed as part of the Benchmarks report. However, much of 2001 was a period of drought, so any changes between 2001 data and earlier measurements could be explained by the climatic conditions. Under natural conditions, groundwater levels can also change by several feet because of natural variations, such as normal "wet" and "dry" years. It will take a longer time period and a larger data collection effort to determine any real trends in groundwater levels. DNRP staff is increasing the frequency of water level measurements in the ambient monitoring wells to improve that source of data.

Where Can Possible Changes to the Local Water Quality be Found?

The purpose of the long-term trend analysis for the "Benchmark" report is to determine if groundwater, on average, is better or worse than it was approximately when the initial ambient samples were taken a decade ago. Part of that evaluation included a statistical analysis of the test results to determine major changes in water quality characteristics.

Staff applied various statistical methods because environmental concentrations fluctuate, partly because of natural variations in the aquifer's actual water quality. For example, seasonal variations may cause flow directions to change slightly and different streams of groundwater can arrive at a well. Groundwater recharge rates also are constantly changing, which results in varying qualities of water added to the aquifer. Sampling results may vary because of the methods of sampling or analysis. In addition, the magnitude of these fluctuations can be different for the chemical parameters. For all these reasons, interpretation cannot simply compare the chemical results in 2001 and determine that they are higher or lower than those in 1989-95. Therefore, the statistical analysis is trying to extract the real and persistent changes in water quality in the aquifer, such as those caused by changing land uses.

The statistical method used for this analysis takes all the analytical data and compares the old against the new data for a given chemical in each well. Most wells have the same chemical concentrations as they did a decade ago. As a result, the data plots as a straight line with some "cloudiness" around the line due to uncontrolled variations. Statistics can provide "confidence limits" about the data. A few points (wells) lie outside the limits and are classified as "outliers" (i.e., locations where new data significantly differs from old data).

The statistical analysis showed that relatively few wells constitute the bulk of these "others." Those do not appear to be located in areas with significant sources of groundwater contamination. (See Appendix D for a table of the results.) Ongoing ambient water quality sampling is necessary to verify changes. The locations identified as outliers are still being checked for some explanation of the variation.

Water Level Monitoring

The Groundwater Protection Program is committed to protecting groundwater quantity and quality. This commitment requires knowledge of whether groundwater levels (a measure of water quantity) are remaining high or declining. Water levels are measured in the ambient water quality wells at the same time as samples are taken. Volunteers on Vashon-Maury Island are also taking monthly water level measurements in their own wells (Figure 3-1). All these DNRP monitoring locations have been accurately located using Global Positioning System equipment to estimate the elevation of the measuring point and turn the measurements into groundwater elevations. Many of the larger public water systems are taking regular water level measurements, which DNRP is adding to the EQuIS groundwater database system.

Interpreting these water levels to determine if the groundwater resources are being depleted is not simple. Water levels change drastically due to natural precipitation fluctuations. A drought emergency existed in early 2001 so the ground water levels would be low, even if no withdrawals had taken place. Fortunately, the drought broke in late 2001. Groundwater levels are cumulative, so the effects of the drought may continue into 2002.

DNRP staff will be doing further analysis of water level data for 2001. More data are being gathered on an on-going basis. The effort will allow a more definitive answer in the future.

Other Achievements

Some results in these other areas of the Groundwater Protection Program include:

- Recognition of the value of the education component, through the award of Centennial Clean Water grant from the Washington State Department of Ecology for 2002.
- Passage of the Groundwater Protection Ordinance.
- Formation of, and the first meeting of, the Vashon – Maury Island Groundwater Protection Committee.

One quantitative measure of public outreach success is the automatic recording of usage ("hits") to the Groundwater Web site. These data are available only for the nine months from March to December 2001. During that period, the website recorded 8,790 hits, or an average of 32 hits per day. During the same period of time, 2,521 web users visited the site. Approximately one-third of these people (600) were return visitors.